REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 8 in the underlying PCT Application No. PCT/EP2004/003278 and adds new claims 9 to 16. The new claims, inter alia, conform the claims to United States Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/EP2004/003278 includes an International Search Report, dated June 14, 2004, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

KENYON & KENYON

Dated: October 12, 2005 By: _____

Clifford A. Ulrich
Reg. No. 42,194
One Broadway
New York, New York 10004
(212) 425-7200
CUSTOMER NO. 26646

SENSOR SYSTEM AND METHOD FOR ITS MANUFACTURE

FIELD OF THE INVENTION

The present invention relates to a sensor system, ~~particularly~~ **e.g.,** for determining the relative humidity in air, ~~as defined in Claim 1,~~ and **to** a method for manufacturing such a sensor system ~~as defined in Claim 7~~.

BACKGROUND INFORMATION

Such sensor systems are often used for determining the relative humidity, for instance, in automotive air conditioners, in household appliances or in copier machines, and are consequently used in great quantities. As a cost-effective type of construction for the sensors used therein, so-called thin-film sensors are often used, whose functioning method is based, for example, on a capacitive measuring principle. The thin-film sensors are usually produced in planar fashion, i.e., all active films **or layers** as well as the contacting areas of the thin-film sensors are accommodated on one surface of the thin-film sensors. Generally, no coatings are then located on the back side of such thin-film sensors.

To manufacture a functional sensor system in as automated a manner as possible, printed circuit boards are fitted with these sensors and appropriately electrically contacted.

[[EP]] **European Published Patent Application No.** 1 046 030 [[B1]] describes a sensor system of this kind, the sensitive region of the sensor being disposed at an opening in the printed circuit board. This type of construction ~~has~~ **may have** the disadvantage that, during operation of the sensor system, both sides of the printed circuit board are constantly exposed to the humidity to be measured. Moreover, additional

EV323018113

production costs **may** result from the provision of the opening in the printed circuit board.

[[The]] U.S. Patent **No.** 4,942,364 describes a resistively acting moisture sensor, in which the moisture-dependent electrical resistance of a suitably prepared non-woven material is determined. This moisture sensor has two connecting wires for insertion into an electric circuit. The connecting wires are bonded to the non-woven material with the aid of a conductive adhesive. Such sensors **may** have the disadvantage that they are not, or are just barely, suitable for automatic assembly on a printed circuit board.

SUMMARY

~~Therefore, the object~~ **An example embodiment** of the present invention ~~is to~~ **may** provide a sensor system which ~~is~~ **may be** producible with low manufacturing expenditure, and which ~~exhibits~~ **may exhibit** great robustness, as well as good measuring accuracy. ~~In the same way,~~ **An example embodiment of** the present invention ~~provides~~ **may provide** a cost-effective and reliable method for manufacturing a sensor system of this kind.

~~This objective is achieved according to the present invention by the features of Claim 1 and Claim 7, respectively.~~

According to **an example embodiment of** the present invention, the contacting area of a thin-film sensor is electrically connected to a contact pad on a printed circuit board using a conductive adhesive. In so doing, the sensor is placed ~~in such a way~~ relative to a surface of the printed circuit board **such** that the contacting area is disposed on a surface of the thin-film sensor facing away from the specified surface of the printed circuit board.

As conductive adhesive, adhesives are considered here which have a comparatively low electrical bulk resistance (~~advantageously~~ **e.g.,** less than 10^{-1} Ωcm, ~~particularly~~ **e.g.,** less than 10^{-2} Ωcm). ~~Preferably, conductive~~ **Conductive** adhesives ~~are~~ **may be** used ~~here~~ which are filled with electroconductive particles and have a proportion of filler of more than 50% by weight, ~~particularly~~ **e.g.,** more than 66% by weight.

In ~~one preferred~~ **an example** embodiment of the present invention, provided between the thin-film sensor and the printed circuit board [[is]] **may be** a mounting adhesive which, on one hand, ~~simplifies~~ **may simplify** the mounting operation and ~~increases~~ **may increase** the operational reliability of the method, and on the other hand, also ~~ensures~~ **may ensure** good thermal coupling of the thin-film sensor to the printed circuit board. In this connection, it ~~is especially favorable if~~ **may be provided that** the mounting adhesive exhibits high thermal conductivity, ~~particularly~~ **e.g.,** greater than 0.3 W/(m·K). The mounting adhesive ~~advantageously has~~ **may have** thermal conductivity greater than**, e.g.,** 0.5 W/(m·K).

~~Advantageous developments of the present invention are found in the dependent claims.~~

According to an example embodiment of the present invention, a sensor system includes: a thin-film sensor including a surface having at least one contact area; a printed circuit board including a surface having at least one contact pad, the thin-film sensor arranged relative to the surface of the printed circuit board such that the surface of the thin-film sensor faces away from the surface of the printed circuit board; and a conductive adhesive adapted to transmit sensor currents from the thin-film sensor to the printed circuit board, the conductive adhesive adhering to the contact area of

the thin-film sensor and the contact pad on the surface of the printed circuit board.

The thin-film sensor may be arranged as one of (a) a humidity sensor and (b) a moisture sensor.

The thin-film sensor may be adapted to operate on a capacitive measuring principle.

The thin-film sensor may include two contact areas, each contact area joined by the conductive adhesive to a corresponding contact pad of the printed circuit board.

The sensor system may include a mounting adhesive arranged at least in one partial area between the thin-film sensor and the printed circuit board.

A thermal conductivity of the mounting adhesive may be greater than 0.3 W/(m·K).

According to an example embodiment of the present invention, a method for manufacturing a sensor system includes: placing a thin-film sensor relative to a surface of a printed circuit board such that a surface of the thin-film sensor on which a contact area is arranged is facing away from the surface of the printed circuit board; and bonding the thin-film sensor to the printed circuit board such that the contact area of the thin-film sensor is electrically connected by a conductive adhesive to a contact pad on the surface of the printed circuit board.

The method may include applying a mounting adhesive on one of (a) the surface of the printed circuit board and (b) the surface of the thin-film sensor prior to the placing step.

According to an example embodiment of the present invention, a sensor system includes: thin-film sensing means including a surface having at least one contact area; printed circuit board means including a surface having at least one contact pad, the thin-film sensing means arranged relative to the surface of the printed circuit board means such that the surface of the thin-film sensing means faces away from the surface of the printed circuit board means; and conductive adhering means for transmitting sensor currents from the thin-film sensing means to the printed circuit board means, the conductive adhering means adhering to the contact area of the thin-film sensing means and the contact pad on the surface of the printed circuit board means.

Further details and ~~advantages~~ **aspects** of ~~the sensor system according to~~ **example embodiments of** the present invention ~~and of the corresponding manufacturing method~~ are ~~derived from~~ **described below in** the following description ~~of an exemplary embodiment~~ with reference to the ~~attached figures, in which~~ **appended Figures.**

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 ~~shows~~ **is** a top view of ~~the~~ **a** sensor system according to **an example embodiment of** the present invention[[;]]**.**

Figure 2 ~~shows~~ **is** a ~~section X-X~~ **cross-sectional view** through the sensor system ~~of the present invention~~ **illustrated in Figure 1 taken along the line X-X**[[;]]**.**

Figures 3a to 3d ~~in each case show a~~ **are** top ~~view~~ **views** of the sensor system ~~of the present invention~~ after different manufacturing steps for ~~clarifying the~~ **illustrating a** manufacturing method.

DETAILED DESCRIPTION

Figure 1 ~~shows~~ **is** a top view of a sensor system according to **an example embodiment of** the present invention. The sensor system ~~is made up of~~ **includes** a thin-film sensor 1 and a printed circuit board 2, of which only a segment is ~~shown here~~ **illustrated**.

Thin-film sensor 1 is used for measuring the relative air humidity, and is based on a capacitive functional principle. Thin-film sensor 1 includes a substrate 1.7, on whose surface Z a base electrode 1.3 (see Figure 2), made of gold in the example ~~shown~~ **illustrated**, is applied. In the exemplary embodiment **illustrated**, substrate 1.7 is made of glass. Base electrode 1.3 is electrically connected via a conductor track 1.2 to a contacting area 1.1a. Both conductor track 1.2 and contacting area 1.1a are located on surface Z of substrate 1.7. A moisture-sensitive **or humidity-sensitive** polymer 1.4 is applied over base electrode 1.3 in a sensitive region of thin-film sensor 1. Applied on this moisture-sensitive polymer 1.4 is a porous moisture electrode 1.5 which is in electrical contact with a further contacting area 1.1b on substrate 1.7 via a connecting electrode 1.6. Thus, on one hand, thin-film sensor 1 has surface Z having the sensitive region and contacting areas 1.1a, 1.1b, and on the other hand, has a passive side or back side opposite surface Z, on which no coating of substrate 1.7 whatsoever was carried out.

Printed circuit board 2 has a surface A on which conductor tracks 2.2 and contact pads 2.1a, 2.1b, ~~here~~ **e.g.,** in the form of thin, electroconductive copper layers, are applied. Thin-film sensor 1 is placed in the sensor system ~~in such a way~~ relative to surface A of printed circuit board 2 **such** that surface Z of thin-film sensor 1, which also has the sensitive region, is facing away from surface A of printed circuit board 2. That is to say, surface A of the printed circuit board and surface Z of thin-film sensor 1 are thus aligned essentially

parallel to each other, but ~~lie~~ **are located** in different geometric planes.

A layer formed by a mounting adhesive 4 is located in the region between thin-film sensor 1 and printed circuit board 2. Mounting adhesive 4 ~~is made of~~ **includes** a polymer matrix and fillers, silver particles in the example ~~shown~~ **illustrated**, so that its thermal conductivity at**, e.g.,** 0.75 W(m·K)**, may be** [[is]] comparatively great.

To transmit sensor currents from thin-film sensor 1 to printed circuit board 2, contacting area 1.1a of thin-film sensor 1 and contact pad 2.1a of printed circuit board 2 are electrically and mechanically interconnected by a conductive adhesive 3. Conductive adhesive 3 thus adheres both to contacting area 1.1a of thin-film sensor 1 and to contact pad 2.1a of printed circuit board 2, so that electrical voltages or currents are transmittable via conductive adhesive 3.

In this type of sensor, the change in capacitance of the sensitive region as a result of water adsorption of moisture-sensitive polymer 1.4 is used as a measured quantity. The resulting currents conducted via conductive adhesive 3 are then evaluated on printed circuit board 2.

To manufacture the sensor system ~~of the present invention~~, ~~according to~~ **as illustrated in** Figure 3a, first of all a printed circuit board 2 is made available, on which conductor tracks 2.2 and contact pads 2.1a, 2.1b are already applied on surface A.

After that, in a first step S1, mounting adhesive 4 is applied on surface A of printed circuit board 2 in the region of the later contact area, thus here between the two contact pads 2.1a, 2.1b (Figure 3b). Immediately after the application of

mounting adhesive 4, the area moistened by mounting adhesive 4 is smaller than the area of substrate 1.7 of thin-film sensor 1.

In a further step S2, as ~~shown~~ **illustrated** in Figure 3c, thin-film sensor 1 is placed relative to printed circuit board 2. In so doing, thin-film sensor 1 is arranged [[in]] such ~~a way~~ that surface Z of thin-film sensor 1, on which contacting areas 1.1 are ~~disposed~~ **arranged**, is facing away from surface A of printed circuit board 2. In other words, the passive, non-sensitive side, thus, the back side of thin-film sensor 1 is joined, ~~that is~~ **e.g.**, adhered, to printed circuit board 2. The amount of mounting adhesive 4 ~~was~~ **is** apportioned in step S1 [[in]] such ~~a way~~ that, after thin-film sensor 1 has been placed on printed circuit board 2, no mounting adhesive 4 is pressed over the edge of thin-film sensor [[2]] **1**, i.e., no mounting adhesive 4 emerges laterally from the joint gap or, for ~~instance~~ **example**, covers contact pads 2.1a, 2.1b as a result of pressing thin-film sensor [[2]] **1** onto printed circuit board 2. It [[is]] **may** thus **be** ensured that after step S2, the position of thin-film sensor 1 on printed circuit board 2 is fixed.

In the following step S3, a conductive adhesive 3 is applied at a first adhesive location onto contact pad 2.1a and contacting area 1.1a. The volume of conductive adhesive 3 at this adhesive location is apportioned [[in]] such ~~a way~~ that conductive adhesive 3 touches both contacting area 1.1a and contact pad 2.1a, and after conductive adhesive 3 has hardened, adheres to these two locations. In this ~~way~~ **manner**, an electrical connection is produced between contact pad 2.1a and contacting area 1.1a. Since contact pad 2.1a and contacting area 1.1a are in two different geometric areas parallel to each other, conductive adhesive 3 is disposed around an edge of thin-film sensor 1. Analogously, contact

pad 2.1b and contacting area 1.1b are interconnected by conductive adhesive 3 ~~with~~ **at** a second adhesive location, so that after step S3, a sensor system ~~according to~~ **as illustrated in** Figure 3d ~~is available~~ **may be provided**.

On one hand, the use of a mounting adhesive 4 **may** mechanically ~~relieves~~ **relieve** the adhesive bond of conductive adhesive 3. On the other hand, the layer of mounting adhesive 4 ~~ensures~~ **may ensure** good thermal coupling of thin-film sensor 1 to printed circuit board 2, ~~particularly~~ **e.g.,** since, as already mentioned, mounting adhesive 4 ~~exhibits~~ **may exhibit** high thermal conductivity. This good thermal coupling [[is]] **may be** particularly advantageous when a temperature sensor is arranged on printed circuit board 2, so that virtually no temperature gradient ~~exists~~ **may exist** between the temperature sensor and thin-film sensor 1, which [[is]] **may be** of ~~great importance~~ **particular significance** for the measuring quality, ~~especially~~ **e.g.,** when measuring the dew point.

Due to the type of construction described, the sensor system may ~~now~~ be used [[in]] such ~~a way~~ that only one surface of printed circuit board 2, ~~namely~~ **e.g.**, surface A, is exposed to the moist air. Therefore, this aspect ~~opens up possibilities~~ **may provide** for manufacturing such printed circuit boards 2 more cost-effectively, and ~~increases~~ **may increase** the robustness of a sensor system of this kind.

ABSTRACT

A sensor system includes a thin-film sensor provided with at least one contact area on the surface thereof, and a printed circuit board provided with at least one contact pad on the surface thereof. The thin-film sensor is arranged in relation to the surface of the printed circuit board such that the surface of the thin-film sensor opposes the surface of the printed circuit board. In order to transmit sensor currents from the thin-film sensor to the printed circuit board, a conductive glue adheres to both the contact area of the thin-film sensor and to the contact pad on the surface of the printed circuit board.